Original Article

Bile duct injuries management: the experience of a high volume liver surgery centre

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Background: Bile duct injuries (BDI) have an incidence that could reach 0.1% to 0.3% during open and laparoscopic cholecystectomy respectively. Nevertheless, they can cause severe complications that could have a strong impact on the life quality of the patients. At worst, all these conditions can evolve to septic shock and finally to the death of the patient.

Methods: The study revised the bile duct lesions recorded at the "San Camillo" hospital database, scoring from 2007 up to 2018. Missing data were recovered through call interviews with the patients themselves to update their current state of health.

Results: Twenty-three lesions were treated over the study time. The study considered 15 anastomoses of patients almost exclusively referred from other places and cities which 11 was primarily treated in our hospital and the remaining 4 in the center from where they came from. The remaining 5 patients, who were not treated with biliary reconstruction, were subjected to drainage by a Kehr tube or trans-hepatic drainage.

Conclusions: The study highlighted that immediate repair represents a valid instrument only for experienced surgeons. On the contrary, if it is performed in the second level center for hepatobiliary surgery, it can lead to worse complications. Therefore, the immediate drainage of the site and the secondary referral to a tertiary specialized hepatobiliary center seems to be the best way to guarantee the resolution of an iatrogenic lesion.

Keywords: Laparoscopy; complication; iatrogenic; bile duct; cholecystectomy

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Introduction

Bile duct injuries (BDI) represent uncommon complications of gallbladder surgery, although they may be due to pancreatic and liver surgery, including liver transplantation.

Currently their incidence is very low reaching 0.1% to 0.3% and 0.08% to 0.6% during open and laparoscopic cholecystectomy respectively (1-3).

Nevertheless, they can cause severe complications, Bile Peritonitis due to the formation of bile collections or billion, jaundice secondary to partial or complete bile duct stenosis, external biliary fistulas (EBF), cirrhosis, portal hypertension. At worst, all these conditions can evolve to septic shock and death of the patient (4,5), especially if not recognized promptly.

Several classification systems have been proposed to adequately describe them over the years to make the best choice regarding the management of each type of lesion.

At first, the Bismuth system was the most used way to classify the BDI, even though it was only able to define

Table 1 Bile duct injuries classification. Hannover classification must be added with letters indicating the injured vessel

Hannover classification	Strasberg classification	Bismuth classification
Type A peripheral leakage	Type A	Type 1
A1 cystic duct leak	Bile leak from cystic duct or liver	Low common hepatic duct (CHD) stricture, with a length of the CHD stump of >2 cm
A2 leak in the gallbladder bed		
Type B biliary tract occlusion	Type B	Type 2
B1 incomplete	Partial occlusion of the biliary tree, most frequently of an aberrant right hepatic duct (RHD)	Middle stricture: length of CHD <2 cm
B2 complete		
Type C tangential injury	Type C	Type 3
C1 lesion <5 mm	Bile leak from duct (aberrant RHD) that is not communicating with the common bile duct (CBD)	Hilar stricture, no remaining CHD, but the confluence is preserved
C2 lesion >5 mm		
C3 extensive lesion at hepatic confluence		
C4 extensive lesion above the hepatic confluence		
Type D complete transection	Type D	Type 4
D1 without defect at the hepatic confluence	Lateral injury of biliary system, without loss of continuity	Hilar stricture, with involvement of confluence and loss of communication between right and left hepatic duct
D2 with defect at hepatic confluence		
D3 at hepatic confluence		
D4 above hepatic confluence		
Type E late stenosis	Type E	
E1 main bile duct short <5 mm	Circumferential injury of biliary tree with loss of continuity	
E2 main bile duct >5 mm	E1 transected main bile duct with a stricture more than 2 cm from the hilus	
E3 at hepatic confluence	E2 transected main bile duct with a stricture less than 2 cm from the hilus	
E4 above hepatic confluence	E3 stricture of the hilus with right and left ducts in communication	
	E4 stricture of the hilus with separation of right and left ducts	
	E5 stricture of the main bile duct and the right posterior sectorial duct	

those that occurred during traditional cholecystectomy, which is the open surgery.

With the improvement and the consequent spreading of the laparoscopic gallbladder surgery technique, the Strasberg Classification started to take place. This classification involves the most common lesions occurring during this kind of surgery. However, it does not allow to describe the detailed localization and extension of the lesion nor the involvement of other structures (e.g., the vessels).

Recently, the new Hannover's classification has allowed us to overcome these limits.

In *Table 1* the three classification systems are compared one to each another (6,7).

Which was the best time to perform reparative treatment has also been the subject of several studies carried out in the last twenty years, without leading to a shared opinion about

the definition of early and late surgery. Some authors use to divide them on 48 hours based cut-off (8); others consider three different repair moments divided into immediate, during the first intervention, early (after two weeks), late (after six weeks) (9).

Finally, the Association Francaise de Chirurgie (AFC) chose 45 days, based on the fact that this was the time necessary to obtain an improvement of the conditions and a resolution of local inflammation and microvascular damage of the bile ducts, which are phenomena that interfere negatively with the quality of the surgical treatment (10).

Other authors reduced this time just to two weeks (5). This time fit better the moment when most of the patients considered in the study were operated. Therefore, it was decided for this study to apply the scheme below:

- Immediate: during the intervention, as soon as the damage is recognized;
- Early: within two weeks of the first operation;
- Late: after two weeks.

Many authors consider that a delayed repair determines a lower rate of postoperative complications in the short and long term (5,9,11). This assumption was not confirmed by the Stewart (12) and Kirk (8) studies. We present the following article in accordance with the STROBE reporting checklist (available at http://dx.doi.org/10.21037/dmr-20-90).

Methods

The present study is a retrospective analysis of BDI patients managed in the Surgical Unit of San Camillo Hospital, which is considered a hepatobiliary surgery reference center for all the South-Center of Italy. Its lesions database was retrospectively reviewed, scoring from 2007 up to 2018; then, missing data about their post-operative period and their current health condition were added by means of call interviews. A total of 23 lesions belonging to 20 patients were divided according to Hannover classification, as reported in *Table 2* and *Figure 1*.

The post-surgery complications were also correlated to the time of repair interventions (*Figures 2,3*). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). All patients have signed informed consent for scientific research. In the present study, review by the ethics committee wasn't required as it's a retrospective study.

Results

Our work is based on a case series made almost exclusively of patients referred from other places. We treated 20 patients with bile duct lesions. We performed 15 hepatojejunostomies. Eleven with the packaging of primary anastomosis in our hospital, and the remaining 4 revising hepatojejunal anastomosis already done in the first center. The last five patients were not treated with biliary reconstruction but only undergone drainage by a Kehr tube or trans-hepatic drainage. More precisely, 3 out of 4 anastomoses (15% of the total) were revised because of postoperative complications. In 2 of them, treated primarily in a second-level center immediately after the recognition of the lesion, the surgeons, who were not specialists in this kind of surgery, decided to convert the operation to laparotomy and to perform a hepatic jejunal anastomosis. In the postoperative period, these patients developed complications that required their transfer to our center and the immediate revision and reconstruction of the anastomosis, after an accurate peritoneal toilette. In all these cases, the presence of bile in the drainage, left in place during the surgery, arouses the suspicion of dehiscence of anastomosis and anticipates the development of external bile fistula. This diagnosis was confirmed by the preliminary tests, like CT and MRI.

One case deserves further studies. Despite the careful investigation carried out during the cholecystectomy intervention, using intra-operative cholangiography and CPRE to identify and define the potential damage, the associated vascular lesion was not readily recognized, and it manifested itself acutely eight days later with a severe hemorrhagic shock, which required several transfusions. Once arrived at our hospital, this patient was immediately undergone to aorto-mesenteric arteriography, re-laparotomy, and direct hemostasis with prolene. Unfortunately, it was not possible to obtain information about the postoperative course and long-term outcome of the patient due to the patient's lack of cooperation.

The third case refers to a lesion not immediately recognized but suspected on the 5th postoperative day after cholecystectomy and choledocoduodenostomy in a patient previously subjected to a gastrectomy according to Billiroth 2. The management of this case follows the same steps as the two already described.

There is a particular case in which the patient had biliary tract abnormalities. He was subjected in our center to a left hepatectomy and suppression of the previous hepato-jeunoanastomosis, because of a tumor that involved the

Table 2 The Hannover classification includes vascular lesions

Type of injury	Hannover classification		
	Code	Nr of lesions	Notes
Peripheral leakage			
Cystic duct leak	A1	2	Mixed with D2 and C1
Leak in the gallbladder bed	A2	1	
Biliary tract occlusion			
Incomplete	B1		
Complete	B2		
Tangential injury			
Lesion <5 mm	C1	3	
Lesion >5 mm	C2	3	
Extensive lesion at hepatic confluence	C3	1	
Extensive lesion above the hepatic confluence	C4		
Complete transection			
Without defect at the hepatic confluence	D1		
With defect at hepatic confluence	D2	5	1d-gd
At hepatic confluence	D3	4	1p
Above hepatic confluence	D4	1	mixed with C2
Late stenosis			
Main bile duct short <5 mm	E1		
Main bile duct >5 mm	E2	1	
At hepatic confluence	E3		
Above hepatic confluence	E4	2	

anastomosis itself about 20 years after its packaging. The first repair was performed in another non-specialist hospital, following a complex BDI occurred during VLC. The patient died due to tumor progression and not because of the complications of the BDI surgery, and for this reason, he was not included in our study.

The 11 biliodigestive derivations operated firsthand at San Camillo can be divided into those where the lesion was immediately recognized but not treated (3 cases) and those recognized only later (8 cases).

In the three cases in which the damage to the bile duct was identified during the surgery, one or more drainages were placed, and the patients were sent to our hospital as soon as possible, where the imaging results defined, which was the best therapeutic procedure to follow. In one case, the intra-cholangiography showed a clear separation between the two biliary stumps, treated in our center by reconstruction of the duct and resection of the V e IV liver segments, because of K gallbladder and biliary fistula. Later, the patient developed hepatic repetitions shown by instrumental follow up.

Two patients out of three died from causes not otherwise specified, many years after the first surgical intervention, probably due to the development of biliary tract tumors. The third case concerns a complicated subtotal cholecystectomy that was converted to open and referred to our center for biliary peritonitis. Then the patient was subjected to a successful biliodigestive derivation, and he

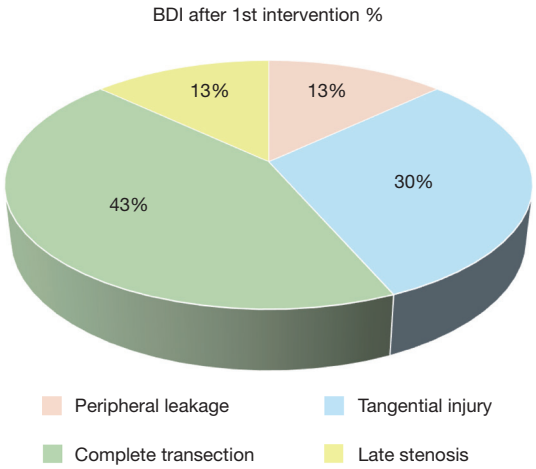

Figure 1 Rate of injuries of bile duct after cholecystectomy.

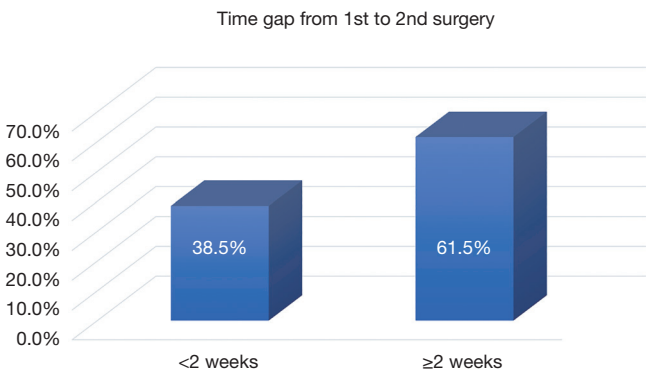

Figure 2 Time interval between the first and the second intervention.

had an experienced uneventful postoperative recovery.

In eight cases, the biliary lesion was recognized after the first intervention, with an increase in cholestasis rates—clinically evident with jaundice. Then, in order to define the lesion, CPRE, CT, cholangio-MRI, and, in specific cases, trans-Kehr cholangiography was performed. In others (2 cases), CPRE was associated with sphincterotomy.

As reported in *Figure 2*, 39% of the interventions had been performed within two weeks ("Early Period"). The choice was associated with the conditions of urgency—acute biliary peritonitis and increasing jaundice—and not with the preference of the surgeon.

The remaining 61% was treated after two weeks according to the opinion of that time is favorable to improve general patient conditions and resolve local inflammation and microvascular damage of the bile ducts, both phenomena that can interfere negatively with the quality of the surgical treatment.

Nonetheless, the total number of major and minor complications was the same for early and late treatments, with the exception of cholangitis significantly whose incidence was higher on early treatments (*Figure 3*).

The rate of cholangitis in the cases of hepatic jejunal anastomosis was significantly higher in those patients who required a second intervention (due to complications of the previous anastomosis).

When the anastomosis was carried out by other centers, 2 out of 3 (66%) patients developed infections of the biliary tract, while only 4 out of 11 (36%) when they were first operated in a specialized center like ours regardless of the time of surgery.

Concerning the patients treated conservatively—i.e., without packaging the biliary-digestive anastomosis – only 1 out of 5 has developed an important infection. A Kehr T-tube drainage was proven to be the right first treatment for biliary leaking (H A1 and A2) and/or for a tangential lesion of bile duct also because it allows monitoring the clinical evolution by trans-Kehr cholangiography.

Discussion

Cholangitis rates after BD anastomosis range from 0.4 to 11% (12-14). The main cause has been recognized to be the rise of intra-ductal pressure in the bile system (15) secondary to stenosis.

For this reason, as confirmed from several studies, we believe that the execution of a good anastomosis, free of tension and well vascularized, performed in a non-inflammatory context, greatly improved the long-term result of the intervention. Several studies confirm this hypothesis and even ours, in fact, shows how the surgical outcome is influenced by the quality of the anastomosis. If the anastomosis is performed primarily by an experienced surgeon, there is a rate of complications, in particular cholangitis, significantly lower. Furthermore, it is also confirmed the importance of an immediate refer of the patient to a specialized hepato-biliary surgery center. In our experience, the majority of complications came from re-intervention over previously attempted BDI management of the iatrogenic biliary lesion by not experienced hands. Moreover, it has been difficult to identify the best management to adopt for this kind of patients, because the first approach was very variable depending on the different second-level centers they came from. For this reason, there was no possibility of standardizing the type of

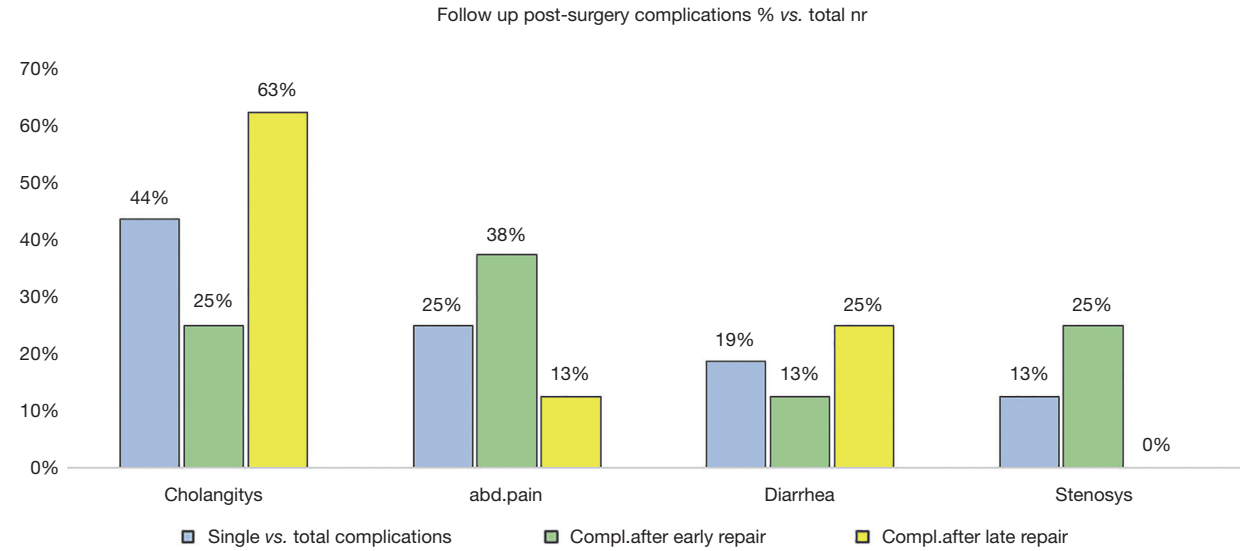

Figure 3 Percentage of post-surgery complications (cholangitis and minor complications).

reconstruction by type of injury.

In our opinion, there should be a uniform classification system regarding the best time to carry out the repair surgery, in order to compare data obtained from different databases and case series. Anyway, it is interesting to point out how the choice of the number of days to consider an intervention early or late is mostly based on local practice, especially on the time necessary for the complex acute contest to be resolved, rather than on standardized parameters, although some reference in the literature exists (5,16,17).

Conclusions

In conclusion, considering both the temporal aspect and the surgeon's competence—as already highlighted by other authors (5,11)—we can affirm that immediate repair represents a valid instrument only for experienced surgeons. On the other hand, if inadequately performed, it can lead to worse complications. Therefore, the immediate drainage of the site and secondary referral to a tertiary specialized hepatobiliary center seems to be the best way to guarantee the resolution of an iatrogenic lesion: "drain now, fix later" (18).

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at http://dx.doi.org/10.21037/dmr-20-90

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Declaration of Helsinki (as revised in 2013). All patients have signed informed consent for scientific research. In

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